

IN THE CLAIMS:

Please CANCEL Claims 7, 8, and 13 without prejudice to or disclaimer of the subject matter contained therein.

Please AMEND Claims 1, 5, 6, 11, and 12, and ADD new Claims 14, 15, and 16 as follows.

1. (Currently Amended) A positioning apparatus comprising:

a movable member movable in a first direction for transmitting a driving force in a driving-axis direction to a stage; and

an electromagnet unit configured and positioned to drive said movable member in the first direction, wherein said electromagnet unit comprises:

a first electromagnet ~~for driving said movable member in the driving-axis direction by forming a magnetic path between said movable member and said first electromagnet and generating first magnetic flux;~~ and

a second ~~electromagnet, which is~~ electromagnet positioned away from said first electromagnet in a second direction which is perpendicular to the first direction,

wherein each of said first electromagnet and said second electromagnet is controlled to generate a magnetic flux having an inverted polarity with respect to the other and arranged in an overlapping direction, for driving said movable member in the same direction as the driving-axis direction of said first electromagnet by forming a magnetic path between said movable member and said second electromagnet and generating second magnetic flux having an inverted plurality from the first magnetic flux.

2. (Original) The positioning apparatus according to claim 1, further comprising current control means for applying currents of inverted polarities having substantially a same value to a first coil and a second coil so as to generate magnetic flux of different polarities in said first electromagnet and said second electromagnet, said first coil wound around a core constituting said first electromagnet and said second coil wound around a core constituting said second electromagnet in a same direction as the first coil.

3. (Previously Presented) The positioning apparatus according to claim 1, wherein in a case when currents of a uniform polarity having substantially a same value are applied to the first coil and the second coil, a coil winding direction of the first coil wound around the core constituting said first electromagnet is opposite to a coil winding direction of the second coil wound around the core constituting said second electromagnet.

4. (Original) The positioning apparatus according to claim 1, wherein said movable member comprises:

a movable core portion configured with a magnetic material, which forms magnetic paths respectively between said first electromagnet and said movable core portion, and said second electromagnet and said movable core portion; and

a supporting member configured with a nonmagnetic material, which supports said movable core portion.

5. (Currently Amended) The positioning apparatus according to claim 2, claim 1, wherein
said electromagnet unit further comprises comprising a third electromagnet, which is
electromagnet positioned away from said second electromagnet in the second direction,
wherein said third electromagnet is controlled to generate a magnetic flux having the
same polarity as the magnetic flux generated by said first electromagnet and having a polarity
inverted with respect to the polarity of the magnetic flux generated by said second electromagnet
and arranged in the overlapping direction of said second electromagnet, for driving said movable
member in the driving axis direction by forming a magnetic path between said movable member
and said third electromagnet and generating magnetic flux having the same polarity as that of the
magnetic flux of said first electromagnet.

6. (Currently Amended) The positioning apparatus according to claim 5, further comprising
current control means, wherein said current control means applies currents to respective coils of
said first electromagnet, said second electromagnet and said third electromagnet at a ratio of
1:2:1.

7-8. (Cancelled)

9. (Original) The positioning apparatus according to claim 1, comprising a plurality of
electromagnet units, having said first electromagnet and said second electromagnet, for driving

the stage in X-axis, Y-axis and Z-axis directions and a rotational direction around respective axes.

10. (Previously Presented) The positioning apparatus according to claim 9, further comprising a carriage stage for carrying said apparatus on an XY plane.

11. (Currently Amended) A charged-particle beam exposure apparatus comprising:
a charged-particle source for irradiating a charged-particle beam;
a first electron optical system, having a plurality of electron lenses, for forming a plurality of intermediate images of the charged-particle source by the plurality of electron lenses;
a second electron optical system for projecting the plurality of intermediate images, formed by said first electron optical system, on a substrate; and
a positioning apparatus, holding the substrate, for driving a stage to a predetermined position to perform positioning of the stage, wherein said positioning apparatus comprises:
~~a movable member movable in a first direction for transmitting a driving force in a driving-axis direction to a stage; and~~
~~an electromagnet unit configured and positioned to drive said movable member in the first direction, wherein said electromagnet unit comprises:~~
~~a first electromagnet for driving said movable member in the driving-axis direction by forming a magnetic path between said movable member and said first electromagnet and generating first magnetic flux; and~~

a second ~~electromagnet, which is~~ electromagnet positioned away from said first electromagnet in a second direction which is perpendicular to the first direction,
wherein each of said first electromagnet and second electromagnet is controlled to
generate a magnetic flux having an inverted polarity with respect to the other and arranged in an
overlapping direction, for driving said movable member in the same direction as the driving-axis
direction of said first electromagnet by forming a magnetic path between said movable member
and said second electromagnet and generating second magnetic flux having an inverted polarity
from the first magnetic flux.

12. (Currently Amended) A device manufacturing method comprising:

a step of installing a plurality of semiconductor manufacturing apparatuses, including a charged-particle-beam exposure apparatus, in a factory; and

a step of manufacturing a semiconductor device by using the plurality of semiconductor manufacturing apparatuses,

wherein the charged-particle-beam exposure apparatus comprises:

a charged-particle source for irradiating a charged-particle beam;

a first electron optical system, having a plurality of electron lenses, for forming a plurality of intermediate images of the charged-particle source by the plurality of electron lenses;

a second electron optical system for projecting the plurality of intermediate images, formed by said first electron optical system, on a substrate; and

a positioning apparatus, holding the substrate, for driving a stage to a predetermined position to perform positioning of the stage, wherein said positioning apparatus comprises:

a movable member movable in a first direction for transmitting a driving force in a driving-axis direction to a stage; and

an electromagnet unit configured and positioned to drive said movable member in the first direction, wherein said electromagnet unit comprises:

a first electromagnet for driving said movable member in the driving-axis direction by forming a magnetic path between said movable member and said first electromagnet and generating first magnetic flux; and

a second electromagnet, which is electromagnet positioned away from said first electromagnet in a second direction which is perpendicular to the first direction,

wherein each of said first electromagnet and said second electromagnet is controlled to generate a magnetic flux having an inverted polarity with respect to the other and arranged in an overlapping direction, for driving said movable member in the same direction as the driving-axis direction of said first electromagnet by forming a magnetic path between said movable member and said second electromagnet and generating second magnetic flux having an inverted polarity from the first magnetic flux.

13. (Cancelled)

14. (New) A positioning apparatus comprising:

a first member;

a second member having at least two sets of electromagnet units, wherein each of the electromagnet units has two electromagnets arranged on each side of said first member in a way to sandwich said first member while maintaining a predetermined gap in a first direction; and

a controller which controls current flow to each of said electromagnet units to drive said first member relative to said second member in the first direction,

wherein said electromagnet units are arranged away from each other in a second direction which is perpendicular to the first direction.

15. (New) The positioning apparatus according to claim 14, wherein said controller controls the current flow to generate magnetic fluxes of different polarities in the electromagnets.

16. (New) A charged-particle-beam exposure apparatus comprising:

exposure means for exposing a pattern onto a substrate;

a stage configured to mount the substrate and position the substrate based on a motion of a first member driven by a positioning apparatus, wherein the positioning apparatus comprises:

said first member;

a second member having at least two sets of electromagnet units, wherein each of the electromagnet units has two electromagnets arranged on each side of said first member in a way to sandwich said first member while maintaining a predetermined gap in a first direction; and

a controller which controls current flow to each of said electromagnet units to drive said first member relative to said second member in the first direction,
wherein said electromagnet units are arranged away from each other in a second direction
which is perpendicular to the first direction.